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PERFORMANCE OF LAYING HENS FED MAIZE OR SORGHUM BASED DIETS CONTAINING DIFFERENT ENERGY LEVELS AND FEEDING SYSTEMS

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Abstract

The effect of substituting maize with sorghum using different energy levels was studied on Isa Brown birds. Results showed that feeding whole sorghum sequentially decreased feed intake significantly (P<0.05). Using different feeding systems and raising the dietary ME levels from 2,300 to 2,600kcal/kg increased feed intake only when whole sorghum was fed in loose mix, while egg production and egg mass increased significantly (P<0.05) only when whole sorghum was fed sequentially. Sequential treatment had significantly (P<0.05) higher feed intake (123.1 g/b/d) compared to either the control (120.9 g/b/d) or the loose-mix (120.7 g/b/d) feeding systems under 2,300 kcal/kg diet. Egg production (%) was significantly (P<0.05) lower with the sequential treatment (58.6) compared to the control (68.5) and loose-mix (68.3) at 2,300 kcal/kg ME diet. Egg weight (g) was highest with the sequential feeding system (62.8g) when the diets contained 2,300 kcal ME/kg than the control diet (60.1g) while the sequential feeding system had significantly (P<0.05) lower egg mass (36.5) compared to either the control (41.1) and the loose-mix (41.6). At low ME diet (2,300 kcal/kg), FCR was better for the loose mix diet (2.92) compared to the control (2.95) and sequential (2.95) treatments at 2,300 kcal/kg ME while the interaction between energy levels and feeding systems showed significant (P<0.05) effect only with the sequential feeding system. The results indicate a more favourable response of laying birds to high energy diets when whole grains are offered sequentially. It was concluded that feeding whole sorghum in loose mix at the laying phase improved efficiency of feed utilisation.

Keywords: *Dietary energy, Layers, Loose mix, Sequential feeding.*

Introduction

Feed intake in poultry is affected by dietary energy level (Rose and Howlider 1987). Birds required energy for both maintenances and production, the energy utilized for production represents the amount of the energy supplied by a diet in excess of the requirement for maintenance (Khan and Scott, 2005).

Energy levels in the diets of laying hens may range between 2,300-3,300 kcal/kg ME (Oluyemi and Roberts 2000)and feed intake in poultry is affected by dietary energy level (MacDonald *et al.*, 2002). Ahmad (2009), using the conventional feeding system, reported that varying the ME density of maize based diets between 2,429 and2,670kcal/kg did not significantly affect the performance of layers. Similarly, Garba (2012) reported similar findings with millet based diets formulated to contain 2,300 – 2,700kcal/kg of ME. This study therefore, was carried out to evaluate the performance of Isa Brown laying birds fed sorghum based diets containing 2,300 or 2,600 kcal/kg ME, using different feeding systems.

Materials and Methods

Experimental Birds

Three hundred and thirty-six (336) Isa Brown laying hens were used for this study. The birds were divided into eight treatments of 42 birds each. Each treatment was divided into7replicates with 6 birds per replicate. The initial weight of the birds ranged from 1,688 to 1,700 g/bird.

Experimental Diets and Feeding Systems

Eight experimental diets were formulated as follows:
Diet 1=maize-based mash diet formulated containing 2,300kcal ME /kg(T1).
Diet 2 = maize-based mash diet containing 2,600kcal/kg ME (T2).

Diets 3, 5 and 7 = Sorghum-based diets containing 2,300 kcal ME/kg (T3, T5 and T7, respectively).Where T3 was a mash, T5 contained whole (unground) sorghum fed as loose mix, while T7 contained whole sorghum but fed sequentially.

Diets 4, 6 and 8 were also sorghum-based diets with ME values of 2,600 kcal/kg ME. WhereT4 was a mash; T6 contained whole sorghum in loose mix, while T8 also contained whole sorghum but fed sequentially. In the loose-mix treatments, both the sorghum grains and the balanced diet were mixed together and served as a single diet, while in the sequential treatments, the sorghum grain was served in the morning by 8.00am and the balance diet was offered in the afternoon by 1.00pm after collecting the left over (if any) of the grain. The experiment was conducted between the 44thand 52ndweeks of age of the birds. Egg production was recorded daily while feed intake and egg weight were recorded weekly. Egg quality analyses were done in the 48thand 52ndweeks of age (Audu *et al.*, 2020).Data generated were subjected to analysis of variance using Stat View Statistical Package (SAS 2002).

Table 1: Gross composition of the experimental diets

Ingredients (%)	T1 (Maize, 2,300 kcal/kg ME)	T2 (Maize, 2,600 kcal/kg ME)	T3, T5 and T7 (Sorghum)*	T4, T6 and T8 (Sorghum)**
Maize	26.2	41.2	0	0
Sorghum	0	0	26.2	41.2
Groundnut cake	16.5	20.3	16.5	20.3
Wheat offal	46.1	27.2	46.1	27.2
Limestone	9.2	9.1	9.2	9.1
Bone meal	1.3	1.5	1.3	1.5
Vitamin/mineral premix	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25
Methionine	0.12	0.12	0.12	0.12
Lysine	0.03	0.1	0.03	0.1
Total	**100**	**100**	**100**	**100**
Crude protein (%)	17	17	17	17
Crude fibre (%)	5.27	5.27	5.27	5.27
Available phosphorus (%)	0.4	0.4	0.4	0.4
Calcium (%)	3.8	3.8	3.8	3.8
Lysine (%)	0.7	0.7	0.7	0.7
Methionine (%)	0.8	0.8	0.8	0.8

*T3, T5 and T7; mash, loose mix and sequential, respectively (2,300kcalME/kg diets).
**T4, T6 and T8; mash, loose mix and sequential, respectively (2,600kcalME/kg diets).

Results

Performance Characteristics of the Experimental Birds Fed the Control Maize and Sorghum Diets Using Different Energy Levels

Increasing the ME level from 2,300 kcalME/kg (T1) to 2,600 kcalME/kg (T2) led to a slightly significant (P<0.05) increase in feed intake for the control maize (Table 2). Egg production was higher with the maize based diets compared to the sorghum based diets, with the highest value recorded for T1 (73.9%) and the least recorded for T3 (68.5%), but the differences were not significant (P>0.05). Egg weight was similar (P>0.05) between T1 and T2 for the maize based diets and betweenT3 andT4 for the sorghum based diets. Egg mass was also similar between the maize based diets (P>0.05), but there was significant (P<0.05) difference when the ME level in the sorghum based diets was increased. A significant (P<0.05) difference in egg mass was also recorded between the maize and sorghum diets containing 2,300 kcal ME/kg (T1) which recorded the highest value of 46.0g and T3 recorded the least value of 41.1g. Energy level had significant (P<0.05) effects on FCR between the maize and sorghum diets with 2,300 kcal ME/kg (T1) which had the best value of 2.65 and T3 which had the worst value of 2.95. Similar trend was observed for yolk content, where the only significant difference was between T1 (24.7%) and T3 (23.3%). Increase in the energy level of the diets increased albumen content (%) in the maize based diet (P>0.05). Proportion of shell (%) was significantly (P<0.05) lower for the high energy density diets compared to the low energy diets.

Table 2. Performance characteristics of laying chickens fed the control maize and sorghum diets using different energy levels

Parameters	Control maize diet (kcal/kg)		Control sorghum diet (kcal/kg)		SEM
	T1 (2,300 kcal/kg ME)	T2 (2,600 kcal/kg ME)	T3 (2,300 kcal/kg ME)	T4 (2,600 kcal/kg ME)	
FI (g/b/d)	120.7^{a}	122.9^{b}	120.9^{ab}	121.9^{a}	0.75
EP (%)	73.9	72.5	68.5	71.6	1.70
EW (g)	60.5^{ab}	61.7^{a}	59.8^{b}	60.0^{b}	0.69
EM	46.0^{a}	43.8^{ab}	41.1^{b}	43.9^{a}	1.62
FCR	2.65^{b}	2.79^{ab}	2.95^{a}	2.81^{ab}	0.10
YC (%)	24.7^{a}	24.4^{ab}	23.3^{b}	24.6^{ab}	0.49
AC (%)	64.7^{ab}	65.6^{ab}	66.0^{a}	63.9^{b}	0.68
PS (%)	9.7^{a}	9.1^{b}	9.9^{a}	8.8^{b}	0.38

^{a,b}Means in the same row followed by different superscripts are significantly different (P<0.05)
FI = feed intake, EP = egg production, EW = egg weight, EM = egg mass, FCR = feed conversion ratio, YC = yolk content, AC = albumin content, PS = proportion of shell.

Interaction Between Feeding System and Energy Level for the Sorghum Based diets

Increase in the ME level of the sorghum based diets significantly (P<0.05) increased feed intake under the loose mix feeding system only(Table 3). Dietary ME level did not affect egg production (P>0.05) under the loose mix feeding system; however, under the sequential feeding system, increasing the dietary ME level from 2,300(T7)to 2,600(T8) kcal/kg significantly (P<0.05) increased egg production. Birds fed the higher energy diet sequentially (T8) recorded the highest egg production (72.9%).Eggmass was significantly (P<0.05) higher with the higher ME diet under the sequential feeding system (T8)but not significant (P>0.05) under the loose mix feeding system. The best FCR was also obtained for birds fed the higher ME diet sequentially (T8), even though it was statistically similar to the values obtained under the loose mix feeding systems (T5 and T6). The FCR for the low energy sequential treatment (T7) was poorest compared to the values obtained for the other treatments (P<0.05).Yolk content was also better under the high energy sequential feeding system (T8) compared to the values obtained for the other treatments (P<0.05).

Table 3 . Performance characteristics of laying chickens fed sorghum based diets using different feeding systems

Parameters	Loose mix		Sequential		SEM
	T5 (2,300kcal/kg ME)	T6 (2,600kcal/kgME)	T7 (2,300 kcal/kgME)	T8 (2,600 kcal/kgME)	
FI (g/b/d)	120.7[a]	123.1[b]	123.1[b]	122.0[b]	0.82
EP (%)	68.3[a]	66.8[a]	58.6[b]	72.9[a]	4.78
EW (g)	60.9	60.4	62.6	61.9	2.77
EM	41.6[b]	40.3[bc]	36.5[c]	44.9[a]	2.84
FCR	2.92[b]	3.09[b]	3.39[a]	2.74[b]	0.23
YC (%)	24.7[b]	24.6[b]	24.9[b]	28.8[a]	0.38
AC (%)	65.7	65.6	65.4	65.7	0.47
PS (%)	9.9[a]	9.7 [a]	9.7[a]	9.5[b]	0.19

[a,b,c]Means in the same row followed by different superscripts are significantly different (P<0.05)

FI = feed intake, EP = egg production, EW = egg weight, EM = egg mass, FCR = feed conversion ratio, YC = yolk content, AC = albumin content, PS = proportion of shell .

Interaction Between Feeding Systems and Energy Levels for the Sorghum Based Diets

Feed Intake

The sequential treatment had significantly(P<0.05) higher feed intake(123.1g/b/d) compared to either the control (120.9 g/b/d) or the loose-mix (120.7 g/b/d) feeding system sat 2,300 kcal/kg. However, at the 2,600kcal/kg ME diets, feed intake (g/b/d) was not significant (P>0.05) across the feeding systems (121.9, 123.1 and 122.4 for the control, loose-mix and sequential feeding systems, respectively).

Table 4: Feed intake (g/b/d) as affected by feeding systems and energy levels

Feeding system	Energy levels (kcal/kg)	
	2,300	2,600
Control	120.9[a]	121.9[ab]
Loose-mix	120.7[b]	123.1[a]
Sequential	123.1[a]	122.4[b]
SEM	0.49	

[a,b]Means along columns and rows followed by different superscripts are significantly different (P<0.05)

Egg production

Egg production (%) was significantly lower with the sequential treatment (58.6) compared to the control (68.5) and loose-mix (68.3) treatments at 2,300 kcal/kg ME diet (Table 5). However, at 2,600kcal/kg ME diet, the highest egg production was recorded for the sequential treatment (72.9), even though it was statistically similar (P<0.05) to that recorded for the control diet (71.6) at 2,600kcal/kg. The value recorded for the loose mix treatment (66.8) was lowest; even though statistically similar to that recorded for the control (71.6).

Table 5: Egg production (%) as affected by feeding systems and energy level

Feeding system	Energy levels (kcal/kg)	
	2,300	2,600
Control	68.5[ab]	71.6[ab]
Loose-mix	68.3[ab]	68.8[b]
Sequential	58.6[c]	72.9[a]
SEM	2.17	

[a,b,c]Means along columns and rows followed by different superscripts are significantly different (P<0.05)

Egg Weight

Egg weight was highest with the sequential feeding system (62.6g) at 2,300kcal/kg ME diet. This value was significantly (P<0.05) different from that obtained with the control diet (60.1g), but statistically similar to that obtained with the loose mix treatments (60.9g) (Table 6). A similar trend was observed with the 2,600 kcal ME /kg diets; however, in this case, the differences were significant between the sequential (61.9g) and the loose mix (60.4g) treatments, while the value recorded for the control treatment (61.4g) was not significantly different from the others.

Table 6: Egg weight (g) as affected by feeding systems and energy level

Feeding system	Energy levels (kcal/kg)	
	2,300	2,600
Control	60.1^{c}	61.4^{ab}
Loose-mix	60.9^{abc}	60.4^{bc}
Sequential	62.8^{a}	61.9^{a}
SEM	0.38	

[a,b,c]Means along columns and rows followed by different superscripts are significantly different (P<0.05)

Egg Mass

Feeding system had significant effect on egg mass under the two energy levels. At 2,300 kcal ME/kg, the sequential feeding system had significantly lower egg mass (36.5g) compared to either the control (41.1g) or the loose-mix (41.6g) treatments (Table7). Raising the energy level of the diets to 2,600kcal ME/kg significantly (P<0.05) increased egg mass to 44.9g for these quentially fed birds.

Table 7: Egg mass as affected by feeding systems and energy level

Feeding system	Energy levels (kcal/kg)	
	2,300	2,600
Control	41.1^{ab}	43.7^{ab}
Loose-mix	41.6^{ab}	40.3^{bc}
Sequential	36.5^{c}	44.9^{a}
SEM	1.44	

[a,b,c]Means along columns and rows followed by different superscripts are significantly different (P<0.05)

Feed Conversion Ratio

FCR was better for the loose mix diet (2.92) compared to the control (2.95) and sequential (2.95) treatments at 2,300kcal/kg ME diet. However, with the 2,600kcal/kg ME diet, FCR was similar across the treatments. Interaction between energy levels and feeding systems shows a significant effect only with the sequential feeding system, where the value obtained with the 2,600 kcal ME/kg diet (2.74) was better (P<0.05) than that obtained with the 2,300 kcal ME/kg diet (3.39) (Table 8).

Table 8: Feed conversion ratio (FCR) as affected by feeding systems and energy level

Feeding system	Energy levels (kcal/kg)	
	2,300	2,600
Control	2.95^{b}	2.79^{ab}
Loose-mix	2.92^{a}	3.09^{ab}
Sequential	3.39^{b}	2.74^{a}
SEM	0.11	

[a,b]Means along columns and rows followed by different superscripts are significantly different (P<0.05)

Discussion

The slight increases in feed intake with increasing dietary energy density observed under the control and loose mix feeding systems contradicted the established negative relationship between feed intake and dietary energy concentration (Doran *et al*.,1983; AFMA 2000). However, increased feed intake with increasing dietary energy level has been reported by other workers (Richard and Jacqueline 2000; Ezeokeke and Iyayi 2001; Yusuf 2008). One possible explanation for the higher feed intake with the higher energy diets observed in this experiment could be due to the fact that the inclusion level of wheat offal was increased from27.2% in the 2,600kcal ME /kg diets to 46.10% in the2,300 kcal ME/kg diets, which must have increased bulkiness of the low energy density diets; thus limiting feed intake due to the limited capacity of the digestive tract. The increased feed intake with increasing ME contents of the diets could also be a pointer to the fact that the dietary energy levels used in this experiment were not enough to satisfy the productive requirements of the birds, thus necessitating higher intake of the high energy diets. Generally, feeding maize as mash resulted in similar egg production irrespective of the energy level. Differences were significant only in the case of the loose mix and sequential sorghum treatments. For the sorghum based diets, sequential feeding of the low ME(2,300 kcal/kg) diet significantly reduced egg production compared to the high ME (2,600 kcal/kg) diet. This negative effect however disappeared when the ME level of the diet was increased to 2,600kcal/kg, as egg production recorded for this treatment was similar compared to that obtained with the control diet and superior to that obtained with the loose mix treatment. Thus, it seems availability of energy for egg production must have limited the performance of the birds fed the low energy diet sequentially. With the other feeding systems increasing the dietary energy density did not significantly affect egg production. These results therefore suggested that increasing the dietary ME density from 2,300 to 2,600 was only beneficial under the sequential feeding system. The higher egg weight recorded when the low energy diet was fed sequentially could be attributed to the low egg production observed for this treatment, as there is an inverse relationship between egg weight and the number of eggs laid (Oluyemi and Roberts, 2000). Other factors that affect egg weight include weight of the hen, breed and other management factors such as nutrition and health condition (Schwagele, 2011). The superiority of the sequentially fed birds in terms of egg weight was maintained even with the high energy diet when egg production was high. Thus factors other than egg number must have influenced this phenomenon. Umar-Faruk *et al*. (2010) and Garba (2012) also reported higher egg weight when millet replaced maize as the major source of energy. It therefore seems that energy source was among the factors that influenced egg weight. Similarly, increasing dietary energy density improved egg mass only in the case of the sorghum based diets fed sequentially. However, within each feeding system, varying the energy level did not affect the other egg quality traits such as contents of yolk, albumin and shell.

Conclusion

It could be concluded that increasing the ME level from 2,300 to 2,600kcal/kg increased feed intake only for the control maize diets (P<0.05) with the control mash diets, while for the control sorghum diets it increased egg weight, egg mass and albumen content, with a concomitant reduction in the proportion of shell (P<0.05). Considering the two whole sorghum feeding systems (i.e. loose mix and sequential treatments), feed intake was the only parameter that was increased by raising the dietary ME level under the loose mix treatment. However, under the sequential feeding system, egg production, egg mass, FCR and yolk content were positively affected (P<0.05). The proportion of shell was also significantly reduced (P<0.05). These results indicate a more favourable response of laying birds to high energy diets when whole grains are offered sequentially.

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